

# Rethinking Human-Centered Computing: Finding the Customer and Negotiated Interactions at the Airport

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During the late 1990s and into 2001, tightly coordinated airline schedules unraveled due to massive delays that were the result of inclement weather, over booked flights and airline operational difficulties. As schedules slipped, the delayed departures and late arrivals resulted in system breakdowns, customers who missed their connections, and airline work activities that fell further out of synch. Air travel became overwhelmingly complex, problematic and fatiguing for customers while providing new operational challenges for airlines. In 2001, the tragedies of 9/11 and the resulting, new airport security procedures added other difficulties to air travel.

The breakdown in the air transportation system raises an interesting question for researchers: *"How can we help improve the reliability of airline operations?"*

In offering some answers to this question, we make a statement about Human-Centered Computing (HCC). First we offer the definition that HCC is a multi-disciplinary research and design methodology focused on *supporting humans as they use technology* by including cognitive and social systems, computational tools and the physical environment in the analysis of organizational systems. We suggest that a key element in understanding organizational systems is that there are external cognitive and social systems (customers) as well as internal cognitive and social systems (employees) and that they interact *dynamically* to impact the organization and its work. The design of human-centered intelligent systems must take this outside-inside dynamic into account. In the past, the design of intelligent systems has focused on supporting the work and improvisation requirements of employees but has often assumed that customer requirements are implicitly satisfied by employee requirements. Taking a *customer-centric perspective* provides a different lens for understanding this outside-inside dynamic, the work of the organization and the requirements of both customers and employees

In this article we will:

- Demonstrate how the use of ethnographic methods revealed the important outside-inside dynamic in an airline, specifically the consequential relationship between external customer requirements and perspectives *and* internal organizational processes and perspectives as they came together in a changing environment.
- Describe how taking a *customer centric perspective* identifies places where the impact of the outside-inside dynamic is most critical and requires technology that can be adaptive.
- Define and discuss the place of *negotiated interactions* in airline operations, identifying how these interactions between customers and airline employees provided new insights

into design problems in the airline system

- Show how taking a *customer-centric* perspective influences the HCC design of an airline system and make recommendations for new architectures and intelligent devices that will enable airline systems to adapt flexibly to delay situations, supporting both customers and airline employees.

## **The Research Approach: Using Ethnography to Understand How the System Works**

This study involved two years of team research within the air travel system. We began our research by doing a pilot study in air traffic control and ramp towers at four airports and in the control rooms of three different airlines. After obtaining this overview perspective, we narrowed our focus to the ground based operations of a large airline. By moving from the overall perspective to the more focused perspective, we obtained a system view that allowed us to understand ground-based airline operations and their relation to flight operations.

Our initial goal was to find a way to increase real-time information flow about delay situations to airport control towers in support of the development of a NASA technology. Additionally, we were to make recommendations for lessening the impact of delays within the airline's system.

We could have used one of a variety of research approaches. If we looked at delays as anomalies in airline processes, then each type of delay we identified could have been viewed as an exception and new rules/use cases [1] could have been designed that would handle each exception. Alternatively, a study could have focused on analyzing and supporting the individual cognitive requirements of each task that is performed in delay or breakdown situations; or on supporting the resolution of delays or changes in travel by producing travel plans that explicitly state constraints [2]. Similarly, we might have chosen a particular focus such as evaluating a specific software and documenting the interactions and needs of a user during delay situations (user-centered design); or on understanding delay related activity within and between the various communities of practice [3] in the airline organization. We chose an ethnographic methodology for our research, because of its ability to uncover the work practice and interactions within a domain and then define and explain that domain for those with other points of view [4]. Also, we chose to focus broadly on ground-based operations. Other researchers have successfully used ethnography in system design in an airline environment [5] [6] [7] [8] but with a more narrowed focus than our study.

In our research, we had the full co-operation and support of airline management who were anxious to gain a better understanding of their operational difficulties. We also had permission to speak to any employee who was willing to talk to us as researchers. We were issued airline badges and given access to operations areas, including the ramp areas where airplanes are parked, checked by mechanics, loaded, fueled, catered and the cabins are cleaned. In the airport terminal, we had access to restricted employee areas, including the station operations center, the activity hub and control center for operations at an airport; the baggage areas; and behind the scenes customer service areas as well as public areas such as the gate and lobby.

We observed and interacted with employees, following the flow of information across the airline

system as it moved from work group to work group. Where possible, we participated in the processes we sought to understand by going through airline training programs and reflecting on our experience as airline customers. We learned several software systems. We observed operations during all work shift periods, day, swing and night shifts, and during weekday, weekend and holiday operation periods. During day-to-day operations, we attended senior team meetings, ramp operations meetings, customer service meetings and operations performance reviews by headquarters personnel. Over time, by sitting with employees or following them as they did their jobs and having informal discussions with them, we came to understand the culture of the organization, its language and its rules of behavior.

Our research team was cross disciplinary, including a computer scientist, and two social scientists with backgrounds in cultural psychology, anthropology and organizational development. We exchanged field notes and discussed what we were observing and learning at each stage of the research. In this way, we gained insights into the domain and its problems, framed questions for further research, analyzed our data, and came to conclusions about what we were seeing. Comparing and contrasting our various perspectives gave us a richer understanding of the airline system. We did not do this work full time; we were all engaged in other research projects during this period.

We began our study of ground-based operations in the station operations center (SOC), focusing on how activities were synchronized across the various work groups involved in routine aircraft “turn-arounds”. A turn-around is the process that begins when an airplane arrives at the gate, is unloaded, fuelled, cleaned, checked mechanically, catered and reloaded with bags and passengers and then “pushes back” for departure. The employees in the operations center are the pulse takers of this process and the arbiters of breakdowns in the work.

To better understand the interactions that were taking place between the work groups involved, one member of our research team moved to the ramp area to observe the work of ramp and bag personnel, fuelers, and mechanics, while another member stayed in the SOC. In this way, we could observe simultaneously from the SOC and the ramp, the complex, synchronized work of the turn-around process. We noted and analyzed employee communication interactions, how they used technology to help manage the arrival and departure of airplanes as well as the flow of aircraft in and out of gate areas, and the process of turning and servicing an airplane. We were able to assess the differences between information available to personnel in the SOC and information available on the ramp area and in the bag room. We gathered data that helped us understand employee approaches to problem solving in delay situations.

After several months, we had gained sufficient understanding in this area and turned our focus to work groups whose job it was to move customers through the airline system. To that end, a team member went through the airline’s customer service training, and we began observing customer service representatives (CSRs) in the lobby check-in area and at the gates, analyzing their work practice and their interactions with customers.

In parallel with our research, we were also traveling extensively using the US airline system and

experiencing the same frustrations with delays and missed connections as the general public. We were airline customers at the same time that we were becoming increasingly sophisticated about airline operations. We began to understand the air travel experience from both the outside and the inside. We were both customer participants and research observers in the airline domain. In our analysis, we saw how easily perspectives can shift between focusing on the customer's experience to focusing on organizational process, and we began to appreciate the value of understanding and holding both perspectives at once.

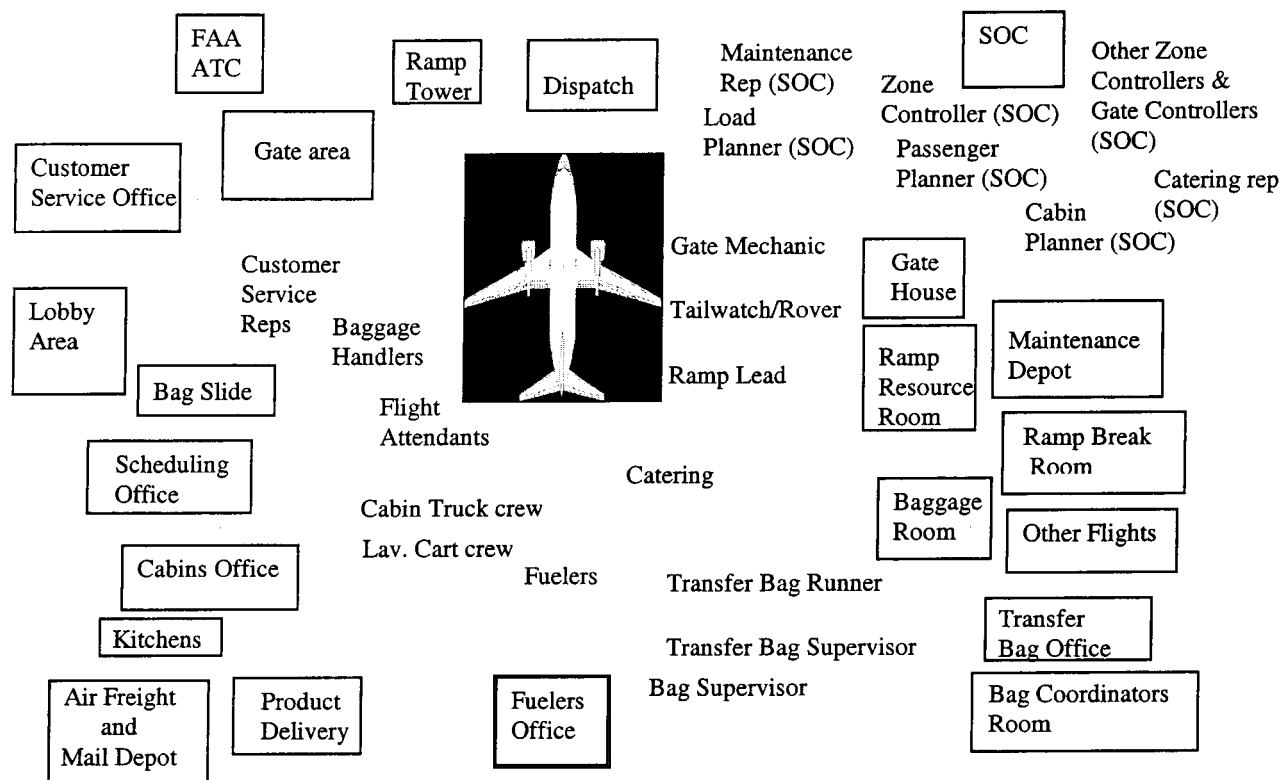
In the lobby and gate areas, we focused on the work of the Customer Service Representatives (CSRs), but we also wanted to document the customers' experience. What was their point of view when they checked in and when they encountered problems while trying to get to their seat on the plane? We could have used questionnaires or conducted focus groups, but we chose to directly approach a customer right after we perceived them as having a problem with the system and ask if we could talk to them. After identifying ourselves as researchers, showing our badges and describing our work, we asked, "What just happened to you?"

In an improvisation on this method, one team member began to "jump the counter," moving back and forth to watch a single transactions from both sides of the counter. *Jumping the counter* was facilitated by that team member having formal training in the software and CSR process, the appropriate badge, security clearance, and the verbal agreement of both the customer and CSR. We could have first observed CSRs and then observed customers, but by moving back and forth during a single transaction, the team member could take the perspective of both the CSR and of the customers, noting what information was available to the customer and what information was available to the CSR and defining the disconnects that resulted due to the differences in information and expectations.

We did not just view the single interaction between these customers and one work group, such as the lobby agent or the gate agent. Instead, we also followed these customers in their trajectory as they moved through the airport from the curb until they boarded the plane, gaining an awareness of the customer experience of breakdowns.

## **An Airline as a Constellation of Work Groups**

During the research, we identified a constellation [3] of activity areas and employee work groups who were involved in operations processes. Figure 1 displays the complexity of the turn-around process. The number of locations (identified in boxes) and the number of tasks and work groups that are required to turn an airplane are identified. All of these tasks and their movement or interaction with others must be synchronized in this process.



**Figure 1: Airline Operations as a Constellation of Work Groups**

As we coordinated our findings, we became aware of the different kinds of information that were available to these work groups and in each of these locations. Some employees were working off paper printouts of the day's flight schedule, making hand-written amendments as they heard about changes over the radio system. We found that the existing technology did not always provide support for these functions. Information that was updated on one computer system was not automatically updated on other systems. The work processes and the technology systems did not support the electronic exchange of many kinds of information, so the communication system was often over-worked and exchanges were limited. There were four radio communication channels specified for different work groups, meaning that different information went over each channel, and not all employees heard about changes as they occurred. Some personnel did not have radios. Others were expected to use telephones to ask questions or input information. Some groups who needed to exchange information directly did not have a way to do it; they had to funnel information through the SOC so that it could be passed on to others..

An analysis of this data revealed two key findings:

- The entire airline operations system was designed on the assumption of the *routine air travel event*. However, the reality was that delays were a "normal" and consistent percentage of operation statistics. The routine air travel event assumed that aircraft would be turned with on-time departures, that customers would move through the system requiring minimum changes in their ticketing, boarding airplanes without problems, that

flights would leave on time, and that customers would always make their connections. However, by observing across work groups during aircraft turn-arounds, we saw airline employees busily improvising solutions to deal with delays in all areas of the system. When flights were cancelled, customers were most often rebooked individually and retroactively, instead of automatically and proactively, implying that they were the exception to be handled on an exceptional basis. Yet routinely, somewhere in the system, flights were bound to be delayed, and the effects of those delays would propagate through the system with greater or lesser impact

- Second, it is not possible to understand the totality of airline delay situations by focusing just on airline employees and the constellation of work groups. We saw it was a mistake to assume delays were purely the result of how the airline's internal operations were implemented and operated and that the remedy was to find ways to manage resources more effectively. Instead, airline operations appeared to be more about managing a complexly interactive internal and external system than about managing resources. Airline operations were being driven as much by the aggregation of "external" factors such as weather and customer requirements as they were by decisions about scheduling, work process and operating resources

## **An Airline as an Outside-Inside Dynamic between Customers and Airline Employees**

As we came to understand airline processes and observed and documented over 200 customer trajectories through the airport, we began to understand the dynamic of the outside-inside interaction that was taking place between customers and employees and the impact that the dynamic was having on the airline system.

### **A Travelers' Tale**

*Approaching a family of four (two adults, two small children) arriving at the terminal curb, our researcher explains the research and asks permission to follow along with the family. The "Mark" family agrees to participate, and they move to the lobby area. The researcher allows the Marks to lead the way, observing how even the "simplest" choices such as selecting an entrance is problematic, because the family's choice places them far from the check-in area they need. Directing the family to wait in the first line they come to, the father goes to find the correct (based on ticket type) line for their check-in. He returns in a few minutes, and they all get in line. When they finally approach the counter, the father offers his name and destination.*

*From the customer side of the counter:*

*The CSR appears busy, typing furiously, apparently searching for their itinerary. The CSR asks several questions related to their itinerary and asks for their identity documents. The CSR informs the Marks that there are not four available seats together. This is not acceptable to the family because of the small children. They insist on four seats together. After several minutes of negotiation while the CSR types into the computer, the CSR tags and checks their baggage and tells the family to go to the departure gate and ask that CSR for their seat assignments.*

*From the CSR's side of the counter:*

*Despite signage displayed to the line, the family approaches the counter without their documentation ready. The CSR has to ask several questions to get the information, while mediating between the software constraints and the information offered by the customer. The order in which the customer presents information is out of sync with the order of the prompt fields in the software. While almost all customers give their name first and then their destination, the software prompts for flight number, time and destination. The prompt field for name does not appear until after the flight has been found. As The CSR searches through several options for seat configurations, the Marks state they may take another flight if they cannot sit together. The CSR has to refresh the seating chart constantly as seats on the flights are being sold and reserved by other CSRs. The CSR decides it will be easier for the gate agent to find seating and sends the family to the gate.*

*The Marks move through security to the gate area, taking a wrong turn and asking another employee for directions and advice. The employee tells them they should be at the gate by this time, thirty minutes before departure. The family rushes to the gate in a panic. At the gate, the CSR looks up their flight information and sees no notation about special seating requirements. By this time there are even fewer seats available on the plane and no four seats together. After some negotiation, the CSR offers the family tickets on another flight leaving shortly from another gate. The Marks accept. The CSR assigns them seats on the other flight, issues boarding passes and then calls down to check on bag status. After the call, she tells the family that it is impossible to move the family's bags to another flight. The Marks decide to take the original flight and return to negotiating their seating. Just before the gate crew closes the doors, the family accepts separate seats with the assurance that the flight attendant will help them sit together once they are on the plane. The family boards the plane, but the flight departs with a delay.*

In the above story, the problem may have begun as far back as the reservation system, perhaps in a failure to prompt for the right questions for seat reservations. However, what we observed were decisions forced by a *failure in software design* to support the work of the CSR, resulting in a problem that moves from lobby to gate without resolution.

Analysis of the data, provided a pattern of these kinds of events. We identified two more key findings:

- *Failures in software design* and the demand for extra work between work groups, requires several employees to deal with one situation that can domino into a delay.
- Certain delays can best be understood by *focusing on the customer as the center of analysis* and this *customer-centric perspective* provides important insights for designing human-centered, intelligent systems for airline operations.

## **Negotiated Interactions**

During our research, we found an apparent anomaly. Some customers took ninety seconds to

check-in, while others took ten minutes and more. Consulting the airline procedures on check-ins, we learned that the airline designed the system based on the assumption of the *routine travel event*, with the expectation that the process would be a one to two minute transaction, with a simple and efficient exchange of information and documents. For us, the ten minute transactions were indicators that more was happening at the counter than was designed for in the system.

As most airline customers might expect, the ten minute plus interactions were not part of the *routine air travel event*. In each case, something had changed in the system, including missed connections, over-bookings, cancelled flights and scheduling problems due to delays. Not all of the changes were on the part of the airlines. Customers approached the counter with complex demands for new ticketing, altered schedules, upgrades and special requests.

Significantly, from the HCC perspective we have defined, we found that often the airline's procedures, training, and information systems did not support the CSRs in dealing with these interactions. When the CSRs were unsupported in their efforts to resolve these situations, they had to find a work-around, if possible, to complete the transaction. If the CSRs could not find a work-around, the customer would often leave the counter and go in search of another employee to resolve the situation. The result was that more than one employee "touched" that customer and that components of the ticketing activity often remained unresolved.

Further, we discovered that customers were unaware of the airline's prioritization policies for re-booking during delay situations, creating a gap between customer expectations and the ability of CSRs to respond to demands. We observed a situation in which a flight was cancelled, and the airline instituted their prioritization policy for re-booking passengers. A First Class customer was upset when he found that international passengers had first priority. The CSR explained that the customer would be delayed for four hours if he missed the next flight, while a customer with an international destination would be delayed for twenty-four hours if she missed a connecting flight. Irritated, the First Class customer continued to negotiate his demands, while other customers waited in line.

In the routine air travel event, a *simple routine transaction* (SRT) between a CSR and customer occurs because there is a shared context, agreed on in the initial ticketing event that defines a travel itinerary. The CSR and customer have only to exchange information and documents. The CSR receives information from the customer and inputs it into the system. All of the necessary information is obvious and available in the system. Upon completion of the transaction, all systems software components (seating, bags, passenger planning, routing, etc.) are updated to reflect the transaction. The customer moves on to receive other services, and the CSR helps the next customers.

However, in delay situations, the pre-negotiated shared context disappears, and a new context must be negotiated with every customer. The employee has to re-book the passenger, while negotiating between the constraints of the system and the customer's requirements. The key element of the ten minute transaction was the negotiated interactions between customers and CSRs. *Negotiated interactions* (NIs) occur when there is a breakdown or change in the system. They identify the



complex, iterative, give and take communication between the CSR and the customer as they attempt to negotiate an outcome satisfactory to both. The outcome will depend on the customer's needs, the availability of resources in the airline system, and will affect those resources.

Once we began to view *negotiated interactions* as a specialized kind of activity of their own, we focused on what they revealed about the system. NIs occur throughout the airline world, because of its dynamic and complex nature. They occur most often between customers and CSRs, but we observed them elsewhere in the organization as employee groups negotiated the use of resources.

NIs represented another key finding:

- *Negotiated interactions* require additional work, can adversely affect the real-time processing of passengers as well as slow the work that goes on between work groups. They result in changes in resources in the airline system, such as available seats on a flight, swapping of a gate area, or the schedule of a fueler on the ramp. NIs give the appearance of flexibility and the ability of airline employees to improvise, but in reality they reflect the de-synchronization of airline activities and failures in system design.

### **Another Traveler's Tale**

*Gina is traveling from San Francisco to Boston. However, because it costs less, she bought a ticket that will take her first to Chicago, where she will then take a connecting flight to Boston. As Gina checks in at the airport, the CSR tells her that the connecting flight from Chicago to Boston has been cancelled. The CSR also notes that no alternative flight has been booked for this customer.*

If Gina's flight had not been cancelled, she would have participated in a simple routine transaction (SRT), gotten her boarding pass and gone on to the gate. However, due to changes in the system (the cancelled flight out of Chicago) a solution to the breakdown must be negotiated between the CSR and the customer.

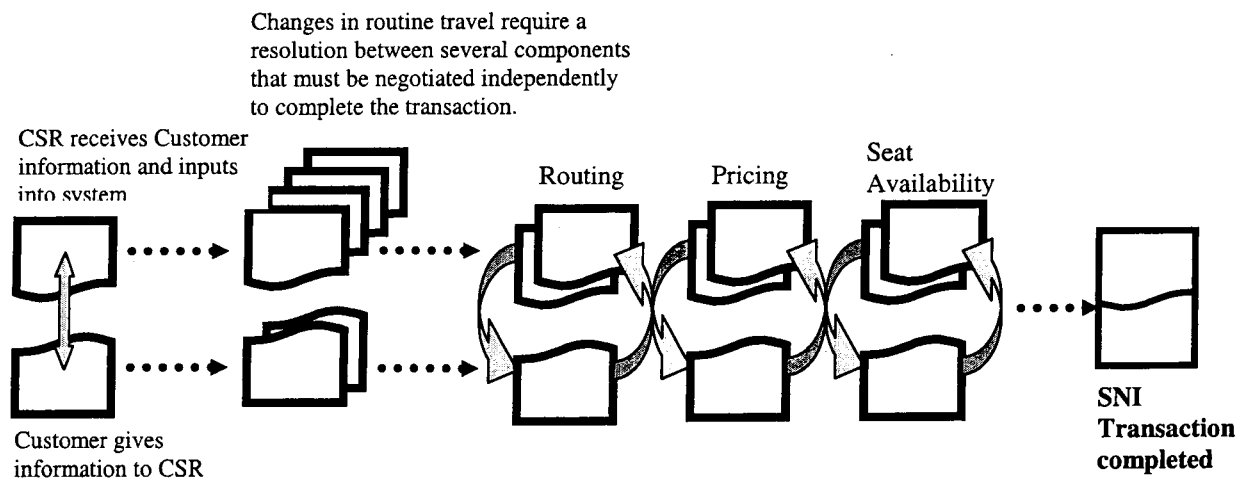
*The CSR begins the process of re-booking Gina by finding and presenting an alternative. She searches through several software displays and finds the next available flight from Chicago to Boston (the usual alternative in a re-booking) and offers it to Gina. Gina refuses the flight, because the new arrival time will make her late for a dinner meeting.*

*The CSR now has a new piece of information relative to the customer's requirements and begins to search the system for another alternative. Because the original ticket is maximized to take advantage of connection times, there is no margin in the itinerary to book Gina on an earlier flight out of Chicago. However, after some searching, the CSR does find two other options: new routing that would take Gina through Denver and have her arrive in Boston at approximately the same time as her cancelled flight; and a direct flight from San Francisco to Boston that would arrive earlier. Gina prefers the direct flight, but the CSR must consider not only routing but pricing and availability in re-booking the customer. The CSR finds that there is availability on both flights, and then searches the system for pricing structures on the tickets. The direct flight from San Francisco to Boston will cost Gina an extra two hundred dollars, and she chooses the flight through Denver.*

*The CSR takes Gina's bags, prints out her boarding passes and moves on to deal with other customers.*

An analysis of Customer-CSR NIs revealed that there are two categories of interaction from a software design perspective: *supported and unsupported*.

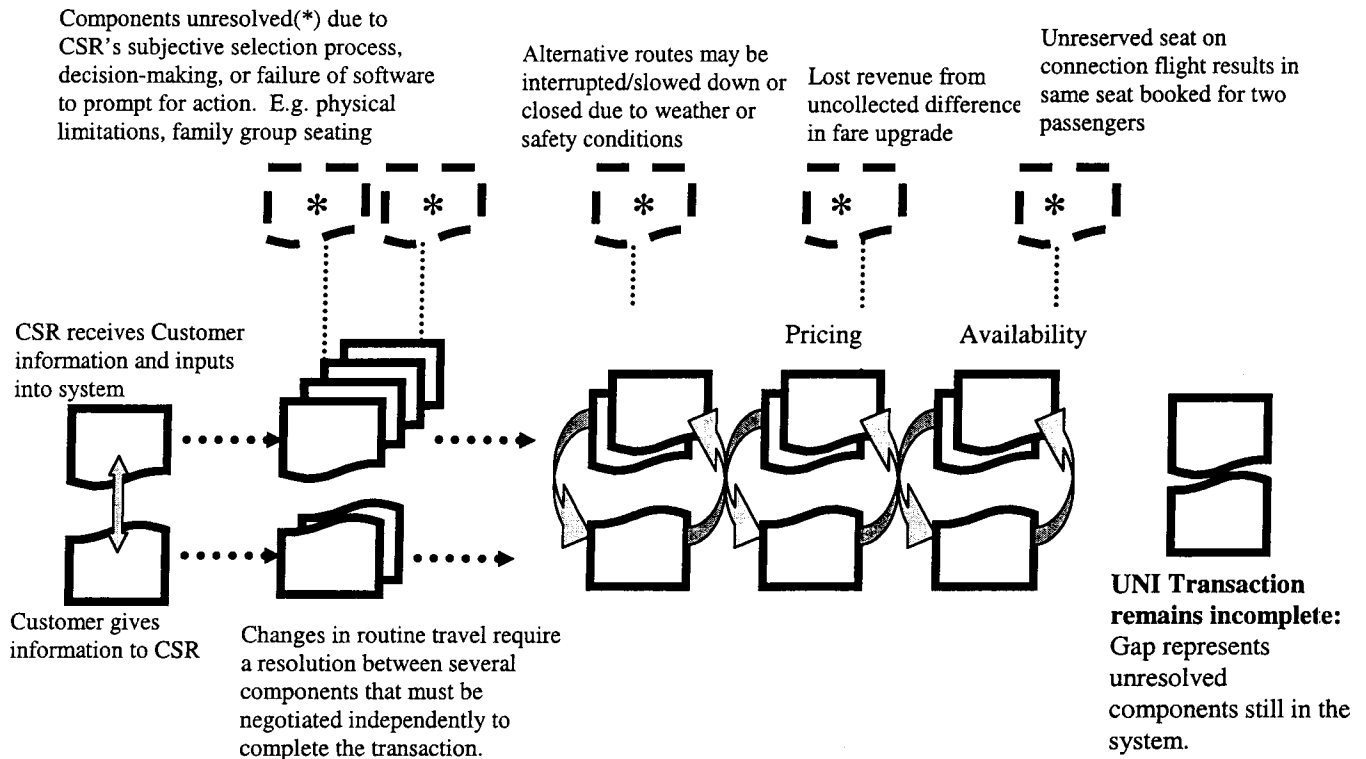
In *supported negotiated interactions (SNIs)*, the software systems contain pertinent information that is not automatically presented. The CSR must remember all necessary components of re-ticketing (pricing, availability and seating are the three most important but there are others as demonstrated in figure3), then search through several screens in the software and find and link the necessary components while negotiating changes with the customer and mediating a resolution. The outcome of the SNI affects downstream organizational resources, but the software automatically updates those systems. Up to this point, Gina's tale represents a *supported negotiated interaction*.



**Figure 2: Supported Negotiated Interaction (SNI)** Due to changes in routine travel the complexity of the transaction multiplies. For the CSR, pertinent, supporting information is available but not automatically displayed and linked to complete the changed transaction. The CSR must keep track of those components and search through several layers of the software systems. After the transaction is complete, all system software components (seating, bags, passenger planning, routing, etc.) are updated to reflect the transaction. Customer moves on to receive other services. CSR helps the next customer.

*Gina boards her plane in San Francisco, but the landing is delayed in Denver due to a thunder storm. She arrives in Denver with a very close connecting time. At the connecting gate, the last passengers are boarding, and Gina puts what she thinks is her boarding pass into the gate reader. It displays an error message. The CSR sends her to the counter where she learns that although the*

*San Francisco CSR could book her on the flight, the software did not allow the CSR to assign a seat as all available seats were being held for assignment at the gate in Denver. The software did not support the CSR in completing the changed transaction. Following another NI, Gina gets a seat and boards the plane.*



**Figure 3: Unsupported Negotiated Interaction (UNI)**

CSR searches the software systems. Some but not all pertinent information is available -- software does not automatically find and link the information necessary to address all components of the transaction. Some components (denoted by \*) of the transaction remain unresolved. Further along in the process, unresolved components related to routing, pricing, availability may cause future systems breakdowns for employees and customers. However, enough components are completed to send the customer on to receive other services. CSR helps next customer.

By following Gina's tale through the whole of her itinerary, we can see that the earlier negotiations, which appeared to be supported, have now become an example of an *unsupported negotiated interaction*. In *unsupported negotiated interactions (UNIs)*, the software system does not contain the information necessary to address all components of the transaction. The CSR must search the systems and find and link information that is available. However, some components will not be addressed or resolved. The inability to assign a seat represents a UNI. The result is that down-stream resources are not updated and will cause breakdowns further along in the process for the organization and the customers.

For researchers, *negotiated interactions* are important. SNIs and UNIs are red flags. Analysis shows that they point to unworkable organizational assumptions about routine processes as well as

technology and system design problems. Alternatively, their identification provides opportunities for improving the system.

## **Design Insights: Using a Customer-Centric Perspective in an HCC Design**

Human-centered computing can support the design of technologies that bridge the outside-inside dynamic that occurs when employees and customers interact, providing workers with the flexibility to deal with changing, real time situations and mediate between customer requirements and organizational processes. However, it is the *customer-centric perspective* that will provide the insights that are pivotal in creating good designs, the information that is inaccessible if the system is viewed only from the inside. The customer-centric perspective changed the way we viewed delay situations and system problems and provided insights that were critical for making recommendations for designing a reliable airline operations system.

The central insights we gathered from taking a customer-centric perspective were:

1. *A customer-centric perspective made us aware of situations and information that were not obvious when looking only at the constellation of work groups within the airline.*
2. *Airline system design assumes a shared context between airline employees and customers.* We found that when changes occur, either those initiated by the airline (due to delays) or those initiated by customers (due to changed requirements), the shared context must be renegotiated and NIs are required.
3. *Customers are mobile and may get “touched” by multiple employees before their problem is solved.* Customers travel from the curb to the aircraft, interacting with many work groups along the way. However, the system has no way of recording any of these partial interactions, so management only sees the problem where it is finally processed. Problems that are seen in the system as “gate” problems were actually “lobby” problems, and the customer has moved from employee to employee seeking a resolution. In contrast, airline employees work at fixed locations in the terminal and have less opportunity to develop a systemic understanding of how the airline is performing.
4. *Customers may have more up-to-date information than employees; employees are no longer authorities on actual airline operations.* For example, airline employees may not have access to updated information (e.g. printouts) while customers may have seen updated information on their travel through the airport (e.g. on the FIDS information screens), or the airline may have contacted the customer directly by email or on their cell phones notifying them of flight changes and delays. It is very difficult to dynamically manage an NI when the airline employee is expected to be better informed than the customer but is not. Given the turnover of staff in an airline, newer employees may be less adept in software use, while passengers are increasingly sophisticated in maximizing/gaming the system to their advantage.

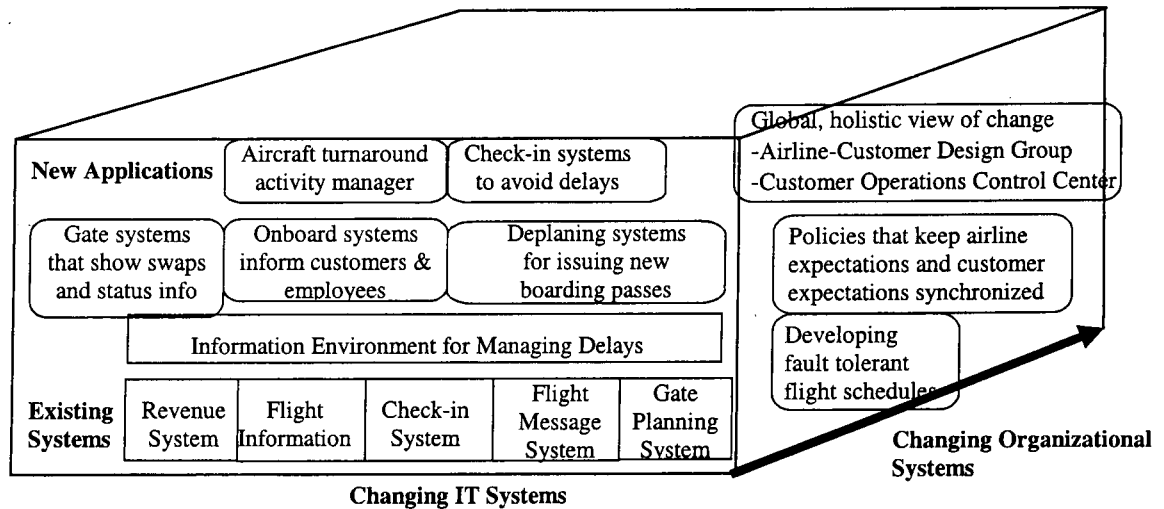
## Designing a “Customer-Centric” Airline System

The above customer centric insights provide an opportunity to rethink the way airlines handle delays and to design a system that will accommodate them.

The key design themes would include:

- Presenting a single “face” to the customer. All employees should have access to the same set of information about actual airline operations and about a customer’s history of interactions with the airline. All CSRs should have a single set of updated, easily available policies for managing and resolving customer problems.
- Proactively managing customer requests to facilitate the creation of a shared context and reduce the need for NIs. It is not difficult to anticipate customer concerns in delay situations: “Did I miss my connection?” “When is the next flight?” “Where are my bags?” “Can I get out today?” “What are my options?” The airline’s information system should anticipate these issues, provide updated information and have it available when the customer approaches a CSR. Second, the customer must be made aware of the airline’s re-booking policies ahead of time so they know what to expect and can make plans for re-organizing their travel.

Redesigning an airline system to incorporate delays as a normal part of operations requires rethinking the organizational and the social systems as well as redesigning the information systems. Figure 4 shows an architectural approach from a customer perspective. The key elements of the architecture are an information environment that ensures that the same updated information is available to all employees and customers. It requires the establishment of new organizational units and policies and new applications that facilitate the proactive management of customer requirements.



**Figure 4: A Customer-Centric Airline System Architecture**

Designing the information environment for a customer-centric airline system is comparatively simple since most of the information required to manage delays already exists somewhere in the airline system. The information environment must:

- Define the information required to manage delays.
- Determine whether the information exists within the organization.
- Determine how to update system information as events unfold.
- Implement a network infrastructure that provides the means for delivering the information to the people who need it.
- Provide a single time source across the organization, facilitating the synchronization of activities.

Organizational changes are critical to rethinking airline operations from a customer-centric perspective, and we recommend two new kinds of organizational groups:

An *Airline-Customer Design Group* would represent the customer perspective when designing future flight schedules, enabling a better trade-off between the airline's desire to maximize revenues, the use of scarce aircraft and crew resources *and* the customer's desires to fly in a system that is more resilient during delays. Designing flight schedules where delays are part of the routine requires a fault tolerant approach. An example would be the ability to reroute planes around a hub that is closed due to weather, a challenging but interesting concept for researchers.

A *Customer Operations Control Center* would focus on traveling customers and be responsible for the constant monitoring of operations to ensure that the needs of customers are managed proactively as delays occur. Key here is developing policies that are visible to all employees and customers and are implemented consistently during delays and cancellations. The policies would

be incorporated into software applications, supporting employee work during delays.

## **Recommendations for the HCC Design of Intelligent Devices**

Human-centered computing should support humans as they use technology and provide designs that make their lives more efficient. In the airline world, the design of intelligent systems that bridge the outside-inside, customer-airline dynamic must provide a flexible and adaptive system that co-ordinates airline resources and customer requirements.

We believe that such a system will require two classes of intelligent systems applications. One class enables the airline operations to be run more effectively. The second class enables the customer to conduct business and travel more effectively. Of course both classes must be linked to bridge the outside-inside dynamic and to operate efficiently.

We recommend a variety of new applications that are designed to create and maintain a shared context between airline employees and customers. These new applications leverage the organizational groups and policies for managing delays (figure 4) with the aim of making the system adaptable to the needs of both customers and employees. The applications include:

- A check-in system that proactively finds alternative schedules for customers in delay situations.
- An aircraft turn-around activity manager that keeps all employees informed as to the status of flights and aircraft turn-arounds, alerts employees when various activities start and finish, and is used to synchronize, plan, and re-plan the schedules of each work system involved in the turn-around.
- A gate system that keeps customers updated as flights are moved to different gates, and keeps customers informed of boarding status. If an airline wants customers to board thirty minutes before departure, then it must inform them of the current status of events.
- An onboard system that would allow flight attendants to inform passengers during flight of issues related to misdirected bags or changed connection information.
- A deplaning system that provides updated information or new boarding passes to customers as they deplane, enabling them to manage connection more effectively in delay situations.
- A system that provides real-time information flow to ramp towers or aircraft control towers, updating them on changes in schedules or delays and allowing for the more efficient use of gate and ramp resources.

Handheld devices, utilizing the information environment described in fig 4 and working off a mobile communications infrastructure would extend this model. The devices would have work group and customer specific applications and would provide up-to-date information throughout the airport.

*Handheld applications developed for internal work group* would enable employees to plan and monitor their activities throughout the day, allowing for both the input and receipt of information by employees who work away from fixed computer infrastructures, and providing for more

flexibility than paper based systems in coordinating aircraft turn-arounds. As changes occur, handheld devices could be used to alert and update employees, enabling rapid re-synchronization of activities.

*Handheld applications developed for customers* would focus on ensuring that customers were alerted to changes in delay situations. Customers in gift shops, rest rooms, restaurants or at gate areas have no visibility of gate changes or flight status delay and cancellation updates. A customer application could provide customized airport navigation, time and departure gate information, information about delays, connections and even arrival gate information so they could arrange to meet a colleague or family member on another flight.

## Conclusions

In this study, we used ethnographic methods to arrive at a systemic understanding of airline operations. We concluded that knowledge of internal work processes, decision making, software design and resource allocation will offer only a limited perspective for understanding airline operations and delays. By expanding the focus of our analysis from aircraft turnarounds and the constellation of work systems within an airline to include customer trajectories and a customer-centric perspective, we came to understand the dynamic of the outside-inside interaction on the organization, the resultant problems and the variety and complexity of delay situations. As we traced the impact of external customer requirements and interactions across the system, we found knowledge that was inaccessible to an organization if it understands and allocates activities only from fixed perspectives of interaction; lobby, gate, planeside, bag room etc. We identified why it is problematic to design an airline based on the assumption of the routine air travel event that deals with delays as an exception.

We found that negotiated interactions served to identify key moments in which both the design of technology and the organizational design were unable to cope with the demands being placed by the external environment. When negotiated interactions are the norm, as in the summer of 2000, this represents fundamental flaws in the system. Negotiated interactions represent opportunities for the development of new technology and services.

Designing airline systems that are adaptive to delay situations requires a fundamental shift away from focusing internally on airline operations. An HCC design must support the needs and requirements of both the airline and customer. A key insight in designing adaptive systems is the need to maintain a shared context between employees and customers in both the routine air travel event and during the negotiated interactions that characterize change and delay situations. Developing the systems to support a shared context requires rethinking the airline organization, designing flight schedules that include organizational and customer perspectives, and re-assessing policies for dealing with delays. Most importantly, the HCC design of user interfaces for intelligent systems must support routine transactions, anticipate the needs demonstrated by negotiated interactions and present the appropriate information to employees to proactively resolve problems.



Finally, we see the need for two classes of intelligent systems. One class enables the airline operations to be run more effectively. The second class enables the customer to conduct business more effectively. These two classes of intelligent systems will merge the customer-airline perspectives and must be linked to operate effectively. This represents a challenge for implementation as new brokers will probably move into the niche for developing intelligent systems for customers, while airlines will remain the architects of their own systems.

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